

Elasticity: An Introduction

In many circumstances, it is not enough for an economist, policymaker, firm or consumer to simply know the direction in which a variable will be moving. For example, if I am a producer, the law of demand tells me that if I increase the price of my good, the quantity demanded by consumers will decrease. The law of demand doesn't tell me what will happen to my total revenue (the price of the good times the number of units sold), however. Whether total revenue increases or decreases depends on how responsive the quantity demanded is to the price change. Will it decrease a little? A lot? Throughout the discipline of economics, in fact, the responsiveness of one variable to changes in another variable is an important piece of information. In general, *elasticity* is a measurement of how responsive one variable is to a change in another variable — that is, how elastic one variable is given a change in the other, *ceteris paribus* (that is, holding all other variables constant).

Because elasticity measures responsiveness, changes in the variables are measured relative to some base or starting point. Consider the following elasticity measurements:

The price elasticity of demand, ϵ_d :

$$\epsilon_d = \frac{\text{percentage change in quantity demanded}}{\text{percentage change in price}}$$

The income elasticity of demand, ϵ_d :

$$\epsilon_d = \frac{\text{percentage change in quantity demanded}}{\text{percentage change in income}}$$

The price elasticity of supply, ϵ_s :

$$\epsilon_s = \frac{\text{percentage change in quantity supplied}}{\text{percentage change in price}}$$

The wage elasticity of labor supply, ϵ_{ls} :

$$\epsilon_{ls} = \frac{\text{percentage change in quantity of labor supplied}}{\text{percentage change in wage}}$$

Activity written by Kelly A. Chaston, Davidson College, Davidson, N.C.

Part A**Extra-Credit Problems**

1. Now, suppose that your economics teacher currently allows you to earn extra credit by submitting answers to the end-of-the-chapter questions in your textbook. The number of questions you're willing to submit depends on the amount of extra credit for each question. How responsive you are to a change in the extra-credit points the teacher gives can be represented as an *elasticity*. Write the formula for the elasticity of extra-credit problems submitted:

$$\epsilon_{ps} = \underline{\hspace{2cm}}$$

2. Now, consider that your teacher's goal is to get you to submit twice as many questions: a 100-percent increase. Underline the correct answer in parentheses.
- (A) If the number of chapter-end questions you submit *is* very responsive to a change in extra-credit points, then a given increase in extra credit elicits a large increase in questions submitted. In this case, your teacher will need to increase the extra-credit points by (*more than / less than / exactly*) 100 percent.
- (B) If the number of chapter-end questions you submit *is not* very responsive to a change in extra-credit points, then a given increase in extra credit elicits a small increase in questions submitted. In this case, your teacher will need to increase the extra-credit points by (*more than / less than / exactly*) 100 percent.

Part B**The Price Elasticity of Demand**

It's easy to imagine that there are many applications for the elasticity concept. Here we will concentrate on the price elasticity of demand for goods and services. For convenience, the measure is repeated here:

$$\epsilon_d = \frac{\text{percentage change in quantity demanded}}{\text{percentage change in price}}$$

Note the following points:

- Price elasticity of demand is always measured *along* a demand curve. When measuring the responsiveness of quantity demanded to a change in price, all other variables must be held constant.
- The price elasticity of demand is typically reported as a positive number, even though the calculation itself is negative; price and quantity demanded move in opposite directions.
- Along a linear demand curve, there are price ranges over which demand is elastic, unit elastic and inelastic.



Figure 17.1

Relationship Between Changes in Quantity Demanded and Price

Percentage change in quantity demanded	>	percentage change in price	> 1	Elastic
Percentage change in quantity demanded	=	percentage change in price	= 1	Unit elastic
Percentage change in quantity demanded	<	percentage change in price	< 1	Inelastic

Part C

Calculating the Arc Elasticity Coefficient

The arc elasticity calculation method is obtained when the midpoint or average price and quantity are used in the calculation. This is reflected in the formula below.

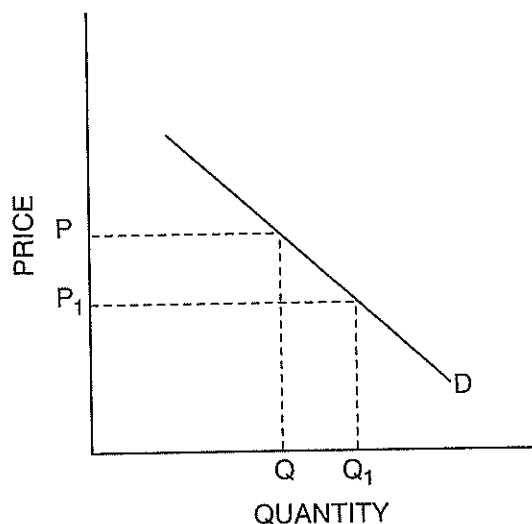
$$\epsilon_d = \frac{\text{percentage change in quantity demanded}}{\text{percentage change in price}} = \frac{\frac{Q - Q_1}{(Q + Q_1) / 2}}{\frac{P - P_1}{(P + P_1) / 2}} = \frac{\frac{\Delta Q}{(Q + Q_1) / 2}}{\frac{\Delta P}{(P + P_1) / 2}}$$

If we have the consumer's or market demand curves, we can precisely calculate the elasticity value, or coefficient. Suppose that price is increased (decreased) from P to P_1 and so quantity demanded decreases (increases) from Q to Q_1 .



Figure 17.2

Calculating the Arc Elasticity Coefficient



By making all numbers positive, we've in effect taken the absolute values of these changes, and so the elasticity coefficient will be positive. Note that we have used the average of the two prices and the two quantities. We have done this so that the elasticity measured will be the same whether we are moving from Q to Q_1 or the other way around.

Part D

Coffee Problems

Suppose Moonbucks, a national coffee-house franchise, finally moves into the little town of Middle-of-nowhere. Moonbucks is the only supplier of coffee in town and faces the following demand schedule each week. Write the correct answer on the answer blanks, or underline the correct answer in parentheses.



Figure 17.3

Cups of Coffee Demanded per Week

Price (per cup)	Quantity Demanded
\$6	80
5	100
4	120
3	140
2	160
1	180
0	200

3. What is the arc price elasticity of demand when the price changes from \$1 to \$2? _____

$$\epsilon_d = \frac{\frac{\Delta Q}{(Q + Q_1) / 2}}{\frac{\Delta P}{(P + P_1) / 2}} = \frac{\quad}{\quad} = \quad$$

So, over this range of prices, demand is (*elastic / unit elastic / inelastic*).

4. What is the arc price elasticity of demand when the price changes from \$5 to \$6? _____

$$\epsilon_d = \frac{\frac{\Delta Q}{(Q + Q_1) / 2}}{\frac{\Delta P}{(P + P_1) / 2}} = \frac{\quad}{\quad} = \quad$$

So, over this range of prices, demand is (*elastic / unit elastic / inelastic*).

Note: Because the relationship between quantity demanded and price is inverse, price elasticity of demand would always be negative. Economists believe using negative numbers is confusing when referring to "large" or "small" elasticities of demand. Therefore, they use absolute or positive numbers, changing the sign on the negative numbers.

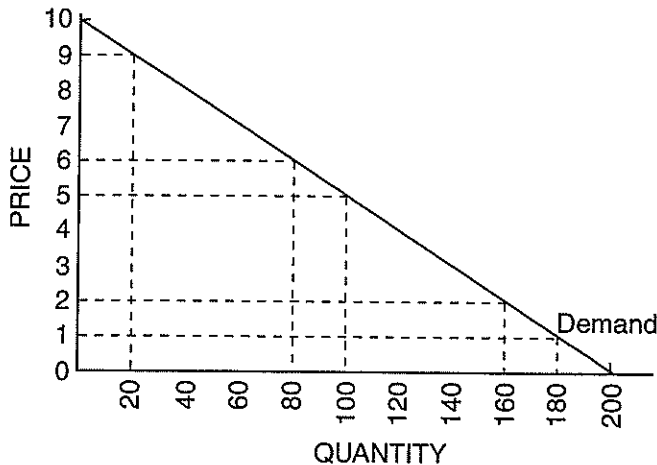
Part E

Now, consider Figure 17.4, which graphs the demand schedule given in Figure 17.3.

Recall the slope of a line is measured by the rise over the run: $\text{slope} = \text{rise} / \text{run} = \Delta P / \Delta Q$.



Figure 17.4

Elasticity of Demand for Coffee

5. Using your calculations of ΔP and ΔQ from Question 3, calculate the slope of the demand curve.

6. Using your calculations of ΔP and ΔQ from Question 4, calculate the slope of the demand curve.

7. The law of demand tells us that an increase in price results in a decrease in the quantity demanded. Questions 5 and 6 remind us that the slope of a straight line is *constant everywhere along the line*. Along this demand curve, a change in price of \$1 generates a change in quantity demanded of 20 cups of coffee a week.

You've now shown mathematically that while the slope of the demand curve is related to elasticity, the two concepts are not the same thing. Briefly discuss the relationship between where you are along the demand curve and the elasticity of demand. How does this tie into the notion of *responsiveness*?

The Determinants of Elasticity of Demand

Suppose we don't know the precise demand schedule for electricity and there is a 20 percent increase in the price of a kilowatt hour of electricity. We know that quantity demanded will decrease, but will it be by less than 20 percent (inelastic demand), exactly 20 percent (unit elastic) or more than 20 percent (elastic demand)? What factors influence the price elasticity of demand? (Remember, *ceteris paribus*!)

Part A

Consider the following representative households in our market for electricity:

Household A: Uses electricity for lighting, appliances and heating.

Household B: Uses electricity for lighting, appliances and heating. Has a heating system that can, with one day's labor, be switched to burn natural gas.

1. Household _____ will have the more elastic demand because of the presence of a _____ good.
2. Because Household A has no available substitutes, should we assume that the quantity demanded of electricity will remain unchanged given the increase in price? _____
Do you think Household A's response will be elastic or inelastic? _____
3. Illustrate the same concept identified above by placing a 1, 2 or 3 by each item below, denoting the least price elastic to the most price elastic. Explain your reasoning.
_____ Demand for insulin
_____ Demand for Granny Smith apples
_____ Demand for running shoes
Rationale:

4. To summarize: Demand is (*more / less*) elastic for goods with many available substitutes.

Activity written by Kelly A. Chaston, Davidson College, Davidson, N.C.

Part B

Consider the following representative households in the electricity market:

Household A: Currently spends \$300 a month on electricity.

The household income is \$1,200 a month.

Household B: Currently spends \$300 a month on electricity.

The household income is \$3,600 a month.

5. Household _____ will have the more-elastic demand, as the expenditures on this good account for a (*smaller / larger*) proportion of its income.
6. Illustrate the same concept identified above by placing a 1, 2 or 3 by each item below, denoting the least elastic to the most elastic. Explain your reasoning.

_____ Demand for chewing gum

_____ Demand for automobiles

_____ Demand for clothing

Rationale:

7. To summarize: Goods that command a (*small / large*) proportion of a consumer's income tend to be more price elastic.

Part C

We expect that the price elasticity of demand will also vary with the nature of the good being considered. Is it a necessity? A durable good? Are we considering the short run or the long run? Consider the following alternatives, and underline the option that correctly completes each statement.

8. The price elasticity of demand for cigarettes: A product that is considered to be a necessity will have a relatively price (*elastic / inelastic*) demand.
9. The price elasticity of demand for automobiles: In the short run, consumers can postpone the purchase of durable goods, and so such goods will have a relatively price (*elastic / inelastic*) demand.
10. Briefly summarize how the nature of the good — necessity, durable good or luxury good — and the time frame affect the price elasticity of demand for electricity.

Part D

Now, suppose that prices in the market for electricity remain constant, but consumers' income increases by 30 percent. Again, we may not know the precise demand schedule but may still be able to use notions of elasticity to speculate about what will happen to demand.

Recall the income elasticity of demand, ϵ_d :

$$\epsilon_d = \frac{\text{percentage change in quantity demanded}}{\text{percentage change in income}}$$

Note in this case, income and quantity demanded are the relevant variables. All other variables, including the price of electricity, are held constant.

11. In measurements of elasticity, if income and quantity demanded move in the opposite direction — that is, if one increases while the other decreases — then the elasticity coefficient will be (*positive / negative*).
12. Remember that if income increases, the demand for a normal good increases and demand for an inferior good decreases. If the good is a normal good, income elasticity will be (*negative / positive*). If it is an inferior good, income elasticity will be (*negative / positive*).

Elasticity and Total Revenue

Consider the following: total revenue (TR) = price (P) x quantity demanded (Q_d).

The responsiveness of quantity demanded to changes in price will determine whether a price increase leads to an increase or decrease in the total revenue generated.

The law of demand tells us that a price increase (decrease) will result in a decrease (increase) in quantity demanded: They move in opposite directions. What happens to TR when price changes is determined by the dominant effect, either the price effect or the quantity effect. In this case, knowing the price elasticity of demand solves the problem.

Consider that

- $\epsilon_d < 1 \Rightarrow \% \Delta \text{ in } Q_d < \% \Delta \text{ in price} \Rightarrow$ The *price effect* dominates.
 If price is increasing ($Q_d \downarrow$ by less), TR will increase.
 If price is decreasing ($Q_d \uparrow$ by less), TR will decrease.
- $\epsilon_d = 1 \Rightarrow \% \Delta \text{ in } Q_d = \% \Delta \text{ in price} \Rightarrow$ Neither effect dominates. TR remains unchanged.
- $\epsilon_d > 1 \Rightarrow \% \Delta \text{ in } Q_d > \% \Delta \text{ in price} \Rightarrow$ The *quantity effect* dominates.
 If price is increasing ($Q_d \downarrow$ by more), TR will decrease.
 If price is decreasing ($Q_d \uparrow$ by more), TR will increase.

Use this information to do the problems below. Fill in the blank or underline the correct answer.

- Price rises from $P = \$5$ to $P_1 = \$6$, and quantity demanded decreases from $Q = 15$ to $Q_1 = 10$.
 - The coefficient of elasticity equals _____.
 - | | | | | |
|-------|---|-------|---|-------|
| (B) P | x | Q | = | TR |
| _____ | x | _____ | = | _____ |
 - | | | | | |
|-----------|---|-------|---|--------|
| (C) P_1 | x | Q_1 | = | TR_1 |
| _____ | x | _____ | = | _____ |
 - $P (\downarrow / \uparrow)$; $TR (\downarrow / \uparrow)$ Demand is (*elastic / unit elastic / inelastic*).
- Price decreases from $P = \$10$ to $P_1 = \$9$, and quantity demanded increases from $Q = 100$ to $Q_1 = 110$.
 - The coefficient of elasticity equals _____.
 - | | | | | |
|-------|---|-------|---|-------|
| (B) P | x | Q | = | TR |
| _____ | x | _____ | = | _____ |
 - | | | | | |
|-----------|---|-------|---|--------|
| (C) P_1 | x | Q_1 | = | TR_1 |
| _____ | x | _____ | = | _____ |
 - $P (\downarrow / \uparrow)$; $TR (\downarrow / \uparrow)$ Demand is (*elastic / unit elastic / inelastic*).

Applying Elasticity to the Real World

Each of the following stories contains an assumption about elasticity of demand. In (A) for each story, decide whether the person's conclusion is right or wrong. In (B) explain your reasoning.

1. I.M. Politico, a candidate for the state legislature, is proposing a large increase in the tax on cigarettes and liquor. He says, "I'm not proposing these taxes to raise revenue but to discourage reckless drinking and the filthy smoking habit. If the prices of cigarettes and liquor go up, most people will quit using them. After all, no one needs to drink or smoke."
(A)
(B)
2. U.R. Kool, a candidate for Congress, proposes freezing the price of gasoline. "There is no substitute for gasoline," he says. "People have to get from one place to another. Economists who say higher prices will discourage people from buying as much gas as before don't live in the real world."
(A)
(B)
3. Councilman Vic Acqua opposed a price increase for water during a recent drought. He claimed that there is no substitute for water. He believes an increase in the price of water (water taxes) will result in the same quantity of water used as before the price went up.
(A)
(B)
4. Sky King, world traveler, says if the airlines want to increase total revenue, they should lower fares for business travelers as well as for vacationers. Both groups should respond equally to a price decrease.
(A)
(B)

From *Master Curriculum Guide in Economics: Teaching Strategies for High School Economics Courses* (New York: National Council on Economic Education, 1985), p. 95

Excise Taxes

Suppose Figures 21.1 and 21.2 show the current supply of Greebes.



Figure 21.1

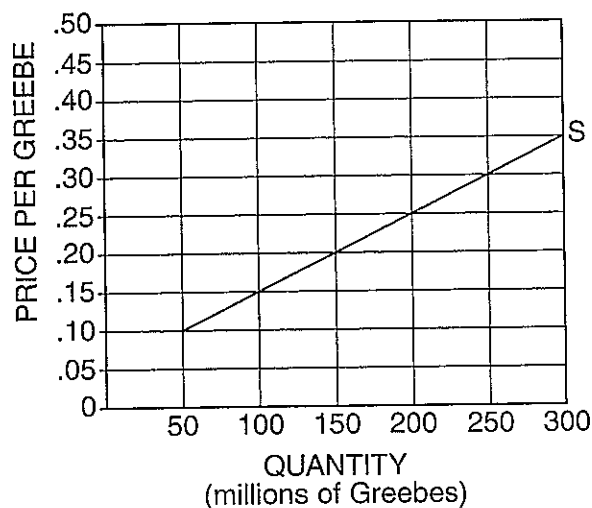
Table of Current Supply Schedule of Greebes

Quantity (millions)	Supply Price Before Tax (\$ per Greebe)	Supply Price After Tax (\$ per Greebe)
50	\$.10	
100	.15	
150	.20	
200	.25	
250	.30	
300	.35	



Figure 21.2

Current Supply Schedule of Greebes



Now, suppose that (to raise revenue for higher education) the government enacts an excise (sales) tax of \$0.15 per Greebe. *This tax will result in a new supply curve for Greebes.* To determine where this new supply curve lies, reason as follows: If before the tax, firms were willing to supply 50 million Greebes at a price of \$0.10, they would now be willing to supply 50 million Greebes only if the price were \$0.25. (Remember: \$0.15 of the price of each Greebe sold is now going to go to the government. So, if the price is \$0.25 and the government is getting \$0.15 of this price, then the seller is receiving the remaining \$0.10.)

Fill in the blank spaces in the table, and draw in the new supply curve that results from the tax. Label the new supply curve S_T .

Adapted from Phillip Saunders, *Introduction to Microeconomics: Student Workbook*, 18th ed. (Bloomington, Ind., 1998).
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What will be the result of this excise (sales) tax on the equilibrium quantity of Greebes? The equilibrium price paid by buyers (P_B)? The equilibrium price received by sellers (P_S)? The revenue received by the government? The income, or revenue, received by sellers after the tax?

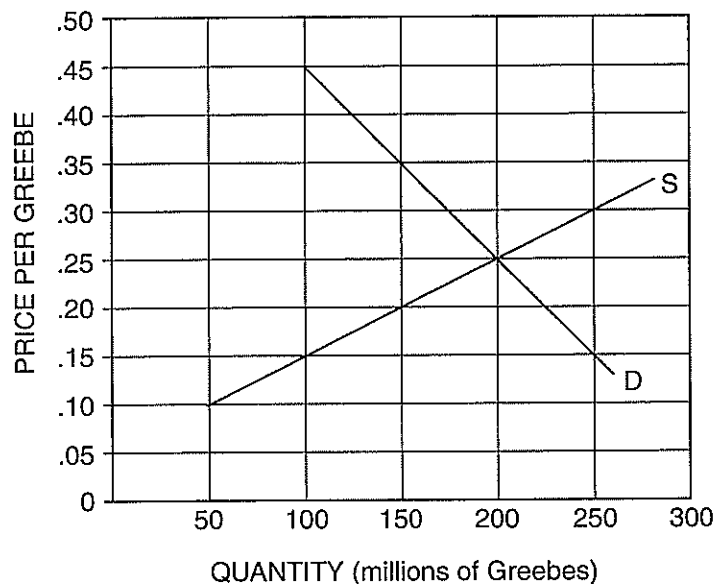
The answers to these important questions will depend on the nature of the demand for Greebes. The next section of this activity will help you determine the effects of a \$0.15 excise tax on Greebes under four different demand conditions.

Part A



Figure 21.3

Relatively Inelastic Demand for Greebes as Compared with D_1 on Figure 21.4



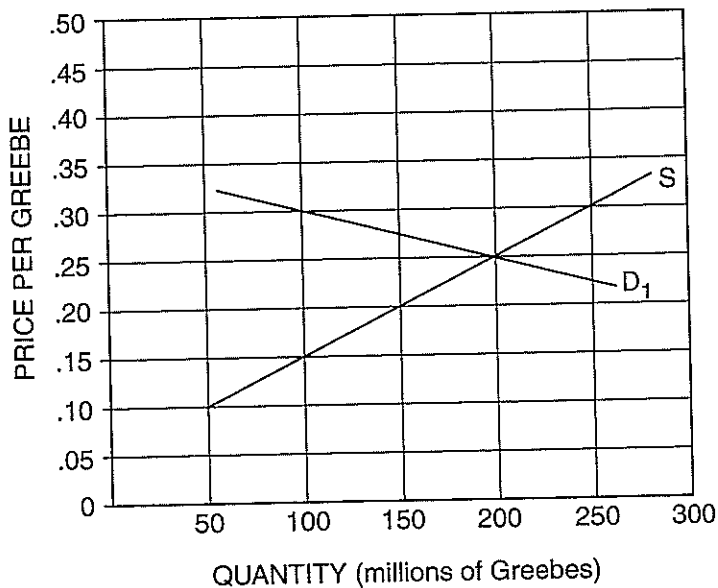
1. On Figure 21.3 above, the equilibrium quantity of Greebes is _____ million Greebes.
2. On Figure 21.3, the equilibrium price of Greebes is _____ per Greebe.
3. Buyers are spending a total of _____ million on Greebes.
4. Sellers are receiving a total of _____ million from selling Greebes.
5. If an excise tax of \$0.15 for each Greebe sold is levied on the sellers of Greebes, the equilibrium price paid by buyers (P_B) will differ from the equilibrium price received by sellers (P_S) by the amount of the tax. Add the new supply curve incorporating the tax to the graph and indicate P_B and P_S . This \$0.15 goes to the government. Under these circumstances:
 - (A) The new equilibrium quantity of Greebes would be _____ million.
 - (B) The new equilibrium price paid by buyers would be _____ per Greebe.

- (C) The new equilibrium price received by sellers (after tax) would be _____ per Greebe.
- (D) Buyers would spend a total of _____ million on Greebes.
- (E) Sellers would receive a total of _____ million (after tax) from selling Greebes.
- (F) The government revenue from this tax would be _____ million.
- (G) _____ million of this revenue would be paid by buyers in the form of higher prices.
- (H) _____ million of this revenue would be paid by sellers in the form of reduced income.
- (I) As a result of the tax, buyers will buy a smaller quantity than before the tax. If so, the sellers would also have a loss of revenue that is not collected by the government. In this case, the *uncollected revenue loss* would be equal to _____ million.

Part B

Figure 21.4

Relatively Elastic Demand for Greebes as Compared with D in Figure 21.3



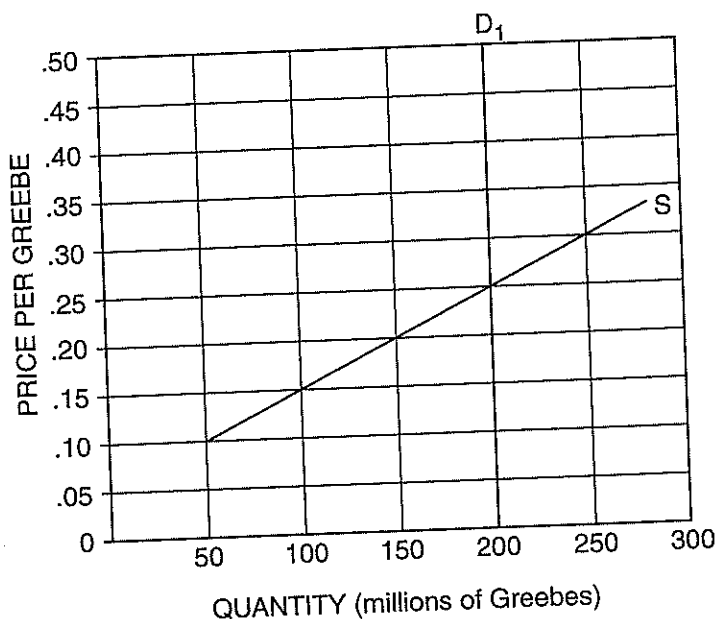
6. On Figure 21.4, the equilibrium quantity of Greebes is _____ million.
7. On Figure 21.4, the equilibrium price of Greebes is _____ per Greebe.
8. Buyers are spending a total of _____ million on Greebes.
9. Sellers are receiving a total of _____ million from selling Greebes.
10. If an excise tax of \$0.15 for each Greebe sold is levied on the sellers of Greebes, the equilibrium price paid by buyers (P_B) will differ from the equilibrium price received by sellers (P_S) by the amount of the tax. This \$0.15 goes to the government. Add the new supply curve incorporating the tax to the graph, and indicate P_B and P_S . Under these circumstances:
 - (A) The new equilibrium quantity of Greebes would be _____ million.
 - (B) The new equilibrium price paid by buyers would be _____ per Greebe.
 - (C) The new equilibrium price received by sellers (after tax) would be _____ per Greebe.
 - (D) Buyers would spend a total of _____ million on Greebes.
 - (E) Sellers would receive a total of _____ million (after tax) from selling Greebes.
 - (F) The government revenue from this tax would be _____ million.
 - (G) _____ million of this revenue would be paid by buyers in the form of higher prices.
 - (H) _____ million of this revenue would be paid by sellers in the form of reduced income.
 - (I) As a result of the tax, buyers will buy a smaller quantity than before the tax. If so, the sellers would also have a loss of revenue that is not collected by the government. In this case, the *uncollected revenue loss* would be equal to _____ million.

Part C



Figure 21.5

Perfectly Inelastic Demand for Greebes



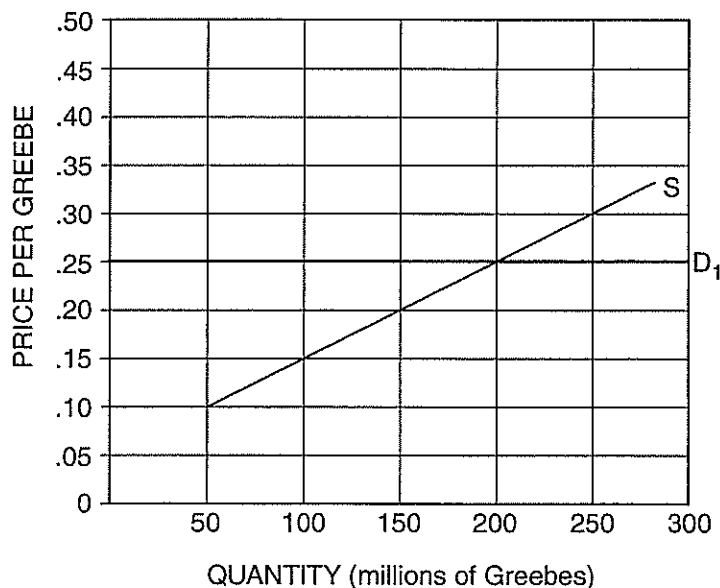
11. On Figure 21.5, the equilibrium quantity of Greebes is _____ million.
12. On Figure 21.5, the equilibrium price of Greebes is _____ per Greebe.
13. Buyers are spending a total of _____ million on Greebes.
14. Sellers are receiving a total of _____ million from selling Greebes.
15. If an excise tax of \$0.15 for each Greebe sold is levied on the sellers of Greebes, the equilibrium price paid by buyers (P_B) will differ from the equilibrium price received by sellers (P_S) by the amount of the tax. This \$0.15 goes to the government. Add the new supply curve incorporating the tax to the graph, and indicate P_B and P_S . Under these circumstances:
 - (A) The new equilibrium quantity of Greebes would be _____ million.
 - (B) The new equilibrium price paid by buyers would be _____ per Greebe.
 - (C) The new equilibrium price received by sellers (after tax) would be _____ per Greebe.
 - (D) Buyers would spend a total of _____ million on Greebes.
 - (E) Sellers would receive a total of _____ million (after tax) from selling Greebes.

- (F) The government revenue from this tax would be _____ million.
- (G) _____ million of this revenue would be paid by buyers in the form of higher prices.
- (H) _____ million of this revenue would be paid by sellers in the form of reduced income.
- (I) As a result of the tax, buyers will buy a smaller quantity than before the tax. If so, the sellers would also have a loss of revenue that is not collected by the government. In this case, the *uncollected revenue loss* would be equal to _____ million.

Part D



Figure 21.6
Perfectly Elastic Demand for Greebes



16. On Figure 21.6, the equilibrium quantity of Greebes is _____ million.
17. On Figure 21.6, the equilibrium price of Greebes is _____ per Greebe.
18. Buyers are spending a total of _____ million on Greebes.
19. Sellers are receiving a total of _____ million from selling Greebes.

20. If an excise tax of \$0.15 for each Greebe sold is levied on the sellers of Greebes, the equilibrium price paid by buyers (P_B) will differ from the equilibrium price received by sellers (P_S) by the amount of the tax. This \$0.15 goes to the government. Add the new supply curve incorporating the tax to the graph and indicate P_B and P_S . Under these circumstances:
- (A) The new equilibrium quantity of Greebes would be _____ million.
 - (B) The new equilibrium price paid by buyers would be _____ per Greebe.
 - (C) The new equilibrium price received by sellers (after tax) would be _____ per Greebe.
 - (D) Buyers would spend a total of _____ million on Greebes.
 - (E) Sellers would receive a total of _____ million (after tax) from selling Greebes.
 - (F) The government revenue from this tax would be _____ million.
 - (G) _____ million of this revenue would be paid by buyers in the form of higher prices.
 - (H) _____ million of this revenue would be paid by sellers in the form of reduced income.
 - (I) As a result of the tax, buyers will buy a smaller quantity than before the tax. If so, the sellers would also have a loss of revenue that is not collected by the government. In this case, the *uncollected revenue loss* would be equal to _____ million.

Part E

21. A famous Supreme Court justice once said, "The power to tax is the power to destroy" sellers. This is more likely to be true the more the demand for the product taxed is relatively (*elastic / inelastic*).
22. If you were a government revenue agent interested in getting the most tax revenue possible, you would suggest putting excise taxes on goods whose demand is (*elastic / unit elastic / inelastic*).
23. Think of some real-world goods on which excise taxes are placed: liquor, cigarettes, gasoline. Do you think that the demand for these goods is relatively elastic or relatively inelastic? Why?

Part F
Consider this newspaper quotation and answer the questions that follow: "The city is planning to place a 10 percent tax on auto parking. The tax would fall on every motorist who uses a space in either the garages and the lots operated by the Public Parking Authority or in privately operated lots and garages."

- and garages.
24. Draw the demand curve and the long-run supply curve for parking lots. Explain why each has the shape you show; in other words, why each is relatively elastic or inelastic.
25. Given the curves you have drawn in Question 24, show the effect of introducing a 10 percent tax: How does the equilibrium position after imposition of the tax compare with the initial equilibrium position?
26. The newspaper quotation implies that the "burden" of the tax will fall entirely upon the driver. Is this true for the case you have developed in Questions 24 and 25 above? Under what circumstances would this be true?